Supplementary Information

Wearable piezoelectric bending motion sensor for simultaneous detection of bending curvature and speed

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S1. Synthesis of bi-axial ZnO NRs

ZnO NRs were synthesized by a hydrothermal method. Experimental details and photograph of setup were explained in reference.[1] Typical chemical reagents for a hydrothermal growth of ZnO NRs were used; Zinc nitrate hexahydrate ($Zn(NO_3)_2 \cdot 6H_2O$) [Sigma Aldrich, ≥ 99.0 %] and hexamethylenetetramine (HMTA) ($C_6H_{12}N_4$) [Sigma Aldrich, ≥ 99.0 %]. 0.42 g of zinc nitrate hexahydrate and 0.21 g of HMTA were dissolved in 100 ml DI water each and vigorously stirred using a vortex. The hydrothermal method of ZnO NRs was conducted in three steps; heating, injecting, and filtering. Firstly, the HMTA solution in a 250 ml round flask was heated into 85 °C using a heating mantle with vigorous stirring at 400 rpm for 10 min. Secondly, two separately divided zinc nitrate solutions were injected simultaneously into the hot HMTA solution via a syringe pump at an injection rate of 2 ml/min for 25 min. Finally, the milky precipitate of ZnO solution was percolated with ethanol via vacuum filtration through 0.2 μm pore size of a membrane filter [Macherey-Nagel, Porafil-CA] and dried at 80 °C for hours to obtain off-white powders of ZnO NRs.

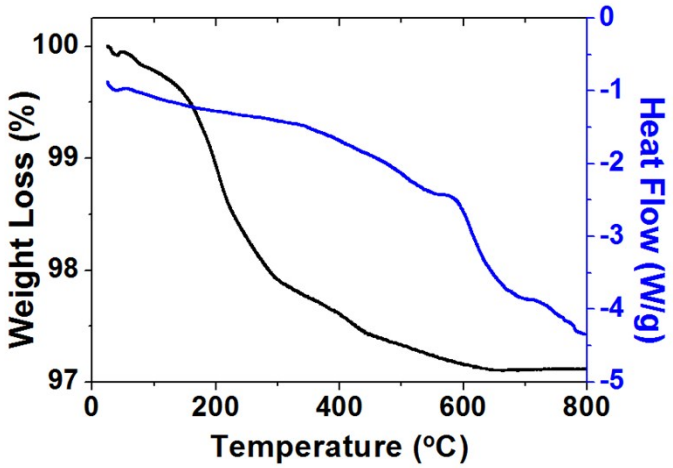

Fig. S2 (a) TG-DSC curves of the ZnO NRs.

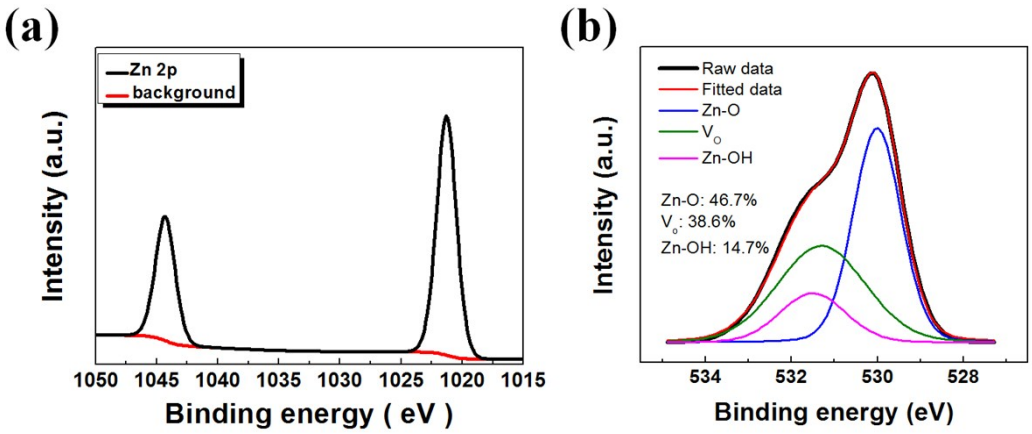

Fig. S3 XPS spectra of (a) Zn-2p and (b) O-1s peaks.

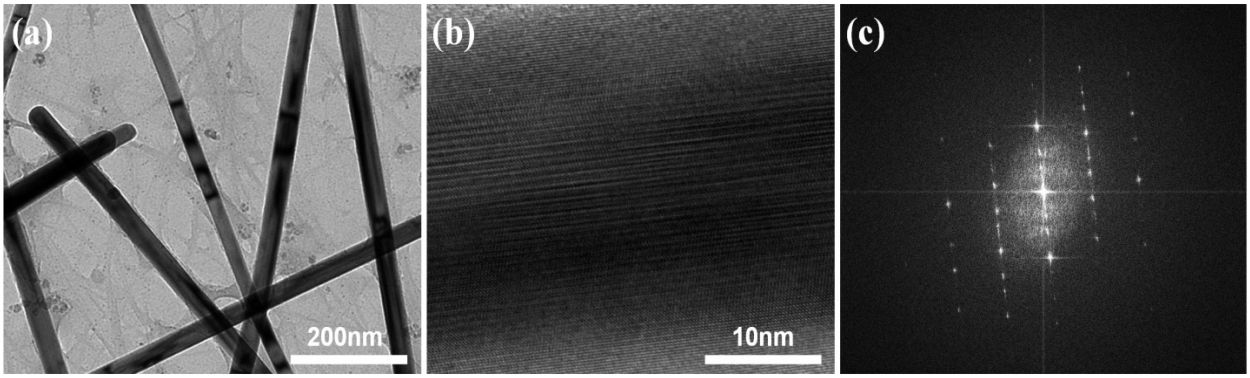

Fig. S4 (a) HRSTEM image of spray-coated Ag NW-SWCNT (b) The crsytalline lattice of Ag NW-SWCNT in its central region and (c) its fast Fourier transform (FFT) patterns.

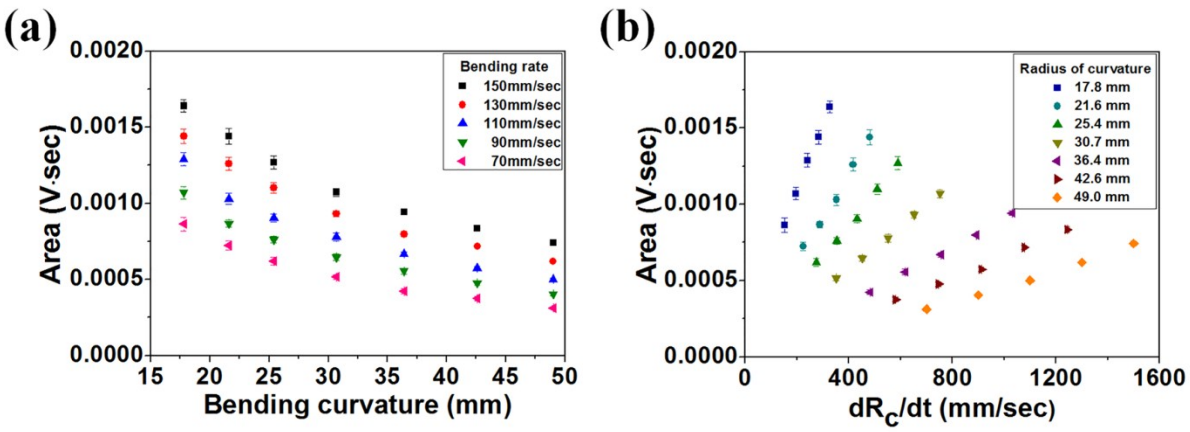

Fig. S5 The voltage area according to (a) the bending curvature and (b) dR_c/dt according to the different bending speed and curvature.

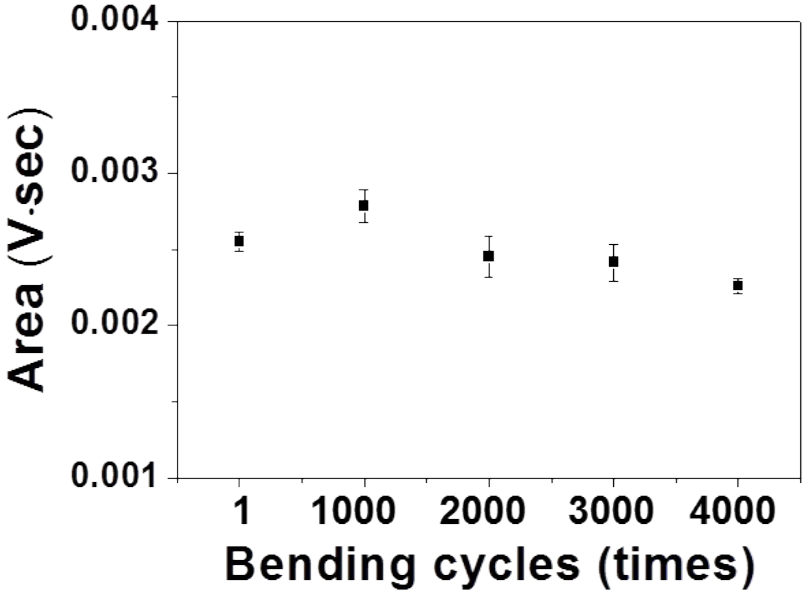

Fig. S6 Durability test of the piezoelectric bending motion sensor at the first and after 1000, 2000, 3000 and 4000 times bending.

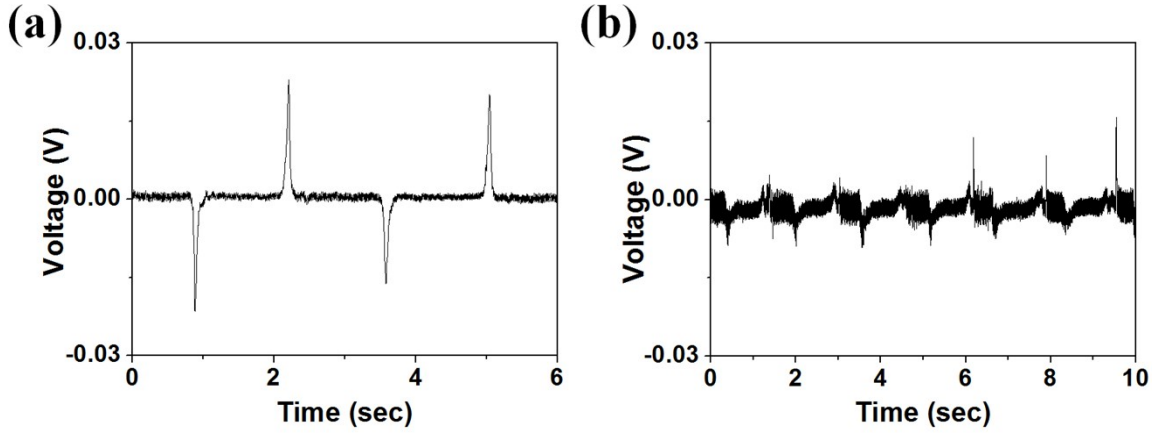

Fig. S7 (a) Output voltage of ZnO contained bending motion sensor. (b) Output voltage of non-ZnO NR contained PDMS : Ag NW-SWCNT bending device.

Notes and references

1 W. S. Jang, T. I. Lee, J. Y. Oh, S. H. Hwang, S. W. Shon, D. H. Kim, Y. Xia, J. M. Myoung, H. K. Baik, *J. Mater. Chem*., 2012, **22**, 20719.

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